The Colourful World of »Ambient Intelligence«

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*There is no reason for any individual
to have a computer in his home*

Ken Olsen, President, Digital Equipment (1977)

AmI: Towards an Animate Universe

Content (1)

➢ What is AmI?

➢ The AmI "Smart Players"

➢ How to make AmI happen!

➢ Scenarios

 ↳ at Home

  ↳ Outdoor

  ↳ at Work

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Content (2)

➢ AmI R&D needs

➢ Need for Support and Complementarities

➢ Combination of Visions, not a too early "Extension of the of AmI Vision"

➢ AmI needs PRESENCE and AWARENESS Technologies

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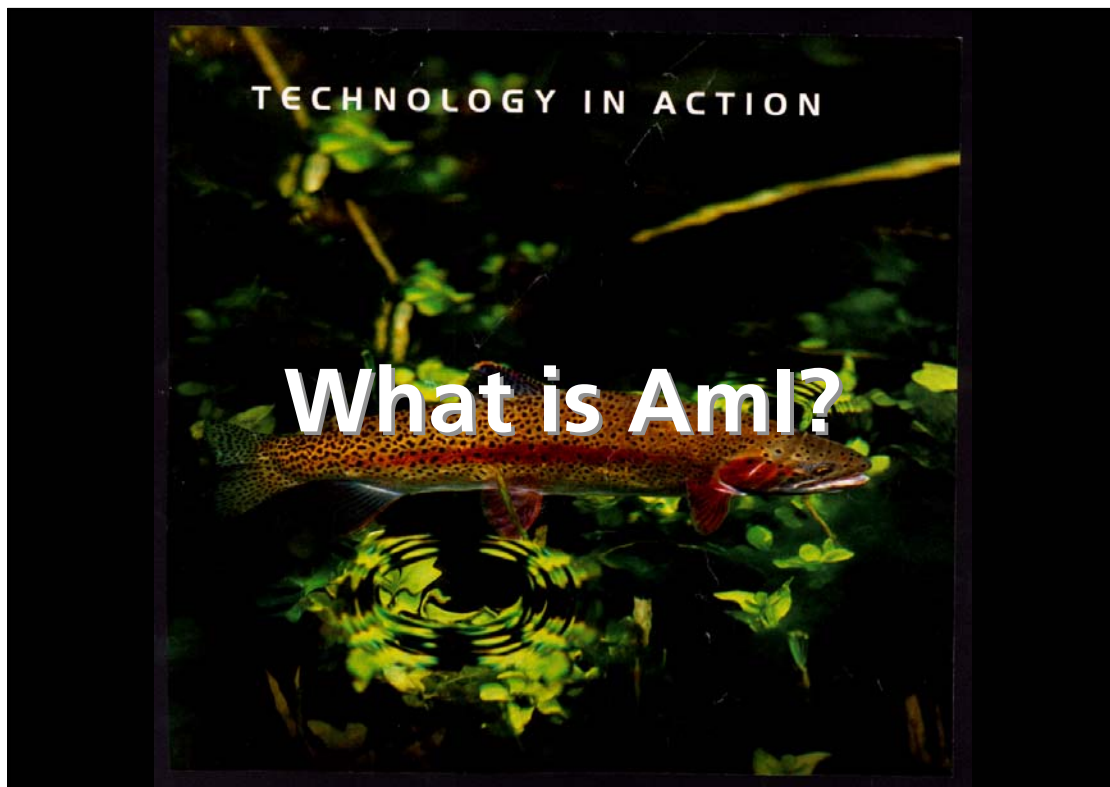
What is Ambient Intelligence?

Ambient Intelligence is all about "intelligent environments" and "smart players" acting and being serviced in those environments.
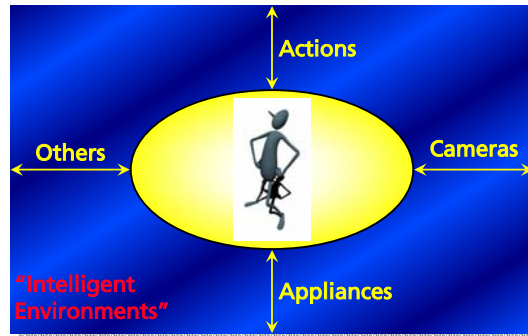
AmI:

7
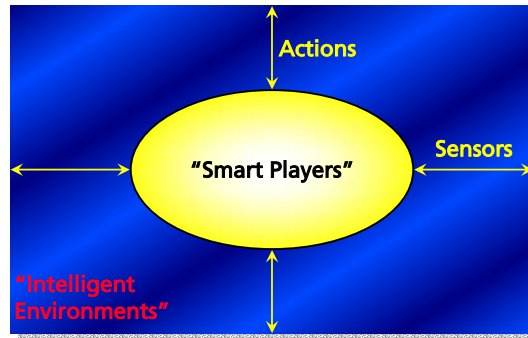
The AmI "Smart Players" (1)

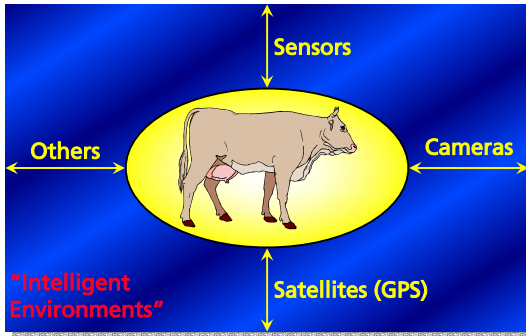**There are many types of "smart players" in AmI**

➤ Humans

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Smart Environments for Human Users

The AmI "Smart Players" (2)

There are many types of "smart players" in AmI

- ➤ Humans
- ➤ Animals

Sensors

Others · Cameras

"Intelligent Environments" · Satellites (GPS)

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The AmI "Smart Players" (3)

There are many types of "smart players" in AmI

- ➤ Humans
- ➤ Animals
- ➤ Smart Objects

Sensors

Others · Cameras

"Intelligent Environments" · Smart Labels

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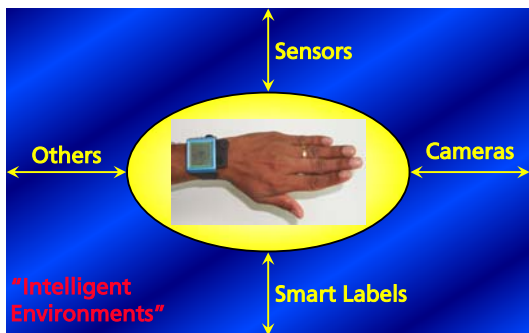
The AmI "Smart Players" (4)

There are many types of "smart players" in AmI

- ➢ Humans
- ➢ Animals
- ➢ Smart Objects
- ➢ Smart Working Places

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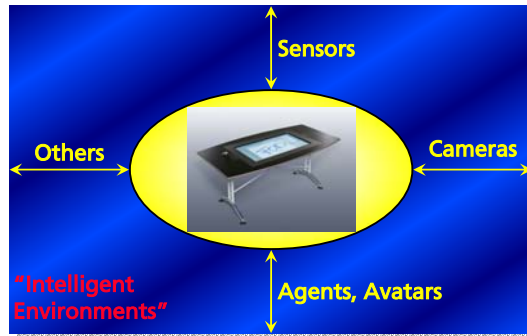Fraunhofer Institut Graphische Datenverarbeitung
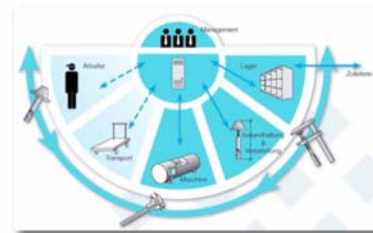
Member of INI-GraphicsNet

The AmI "Smart Players" (5)

There are many types of "smart players" in AmI

- ➢ Humans, Animals, Smart Objects
- ➢ Smart Working Places
- ➢ Smart Machines (and other smart processes, smart production environments, etc.)

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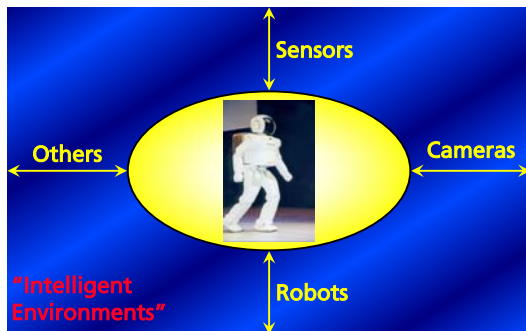
The AmI "Smart Players" (6)

The AmI Vision is therefore …

- ➤ … **not only** about human-centric dialogue and communication

- ➤ … but **all about** "Smart Players" interacting with and getting services from intelligent environments

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JOSÉ CARVALHO

How to make
AmI happen!

Challenges raised by pervasive ICT

Where is the difference?

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Ubicomp: Visions

Zur Anzeige wird der QuickTime™
Dekompressor „TIFF (Unkomprimiert)"
benötigt.

Information Appliances

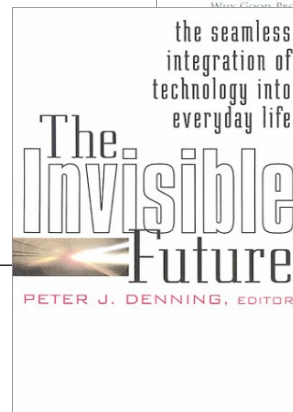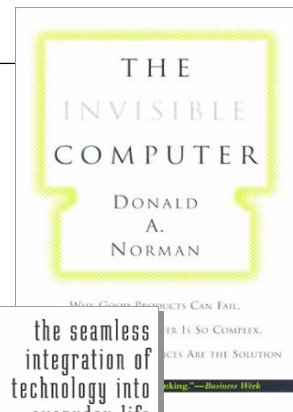➢ Don Norman (UCSD, later Apple & HP)

Ubiquitous & Pervasive Computing

➢ Mark Weiser (Xerox); IBM

Ambient Intelligence

➢ EU ISTAG
   e.g., Emile Aarts (Philips),
       Hartmut Raffler (Siemens), …)

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THE INVISIBLE COMPUTER

DONALD A. NORMAN

the seamless integration of technology into everyday life

The Invisible Future

PETER J. DENNING, EDITOR

AmI and Pervasive Computing

Common Goal: ICT is becoming invisible – but everywhere, anytime, and for everybody

Technology Push	Pervasive Computing	Evolution of today's ICT primary industries
Usage Pull	AmI	Transition to new primary ICT industries

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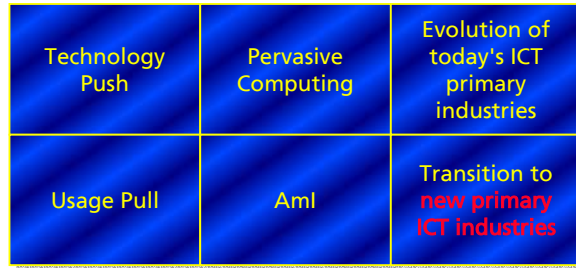
To make AmI happen we need (1)

➢ Vanish from thought

↳ Do the "obvious" - **be context aware**

- don't demand input from the user if her intentions can be infered from the context.

↳ Network yourself - **be self-organizing**

- Don't expect the user to orchestrate multiple -- invisible!? -- devices to cooperate in order to fulfil her needs

↳ Speak the language of the user - **be multimodal**

- allow the user to interact in a natural way (voice, gesture)

↳ **Act Coherent!**

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To make AmI happen we need (2)

➤ Vanish from thought

➤ Coherence

"Smart Player"

| Command & Control by User | Command & Control by Central Component | Command & Control by Self-Organization |
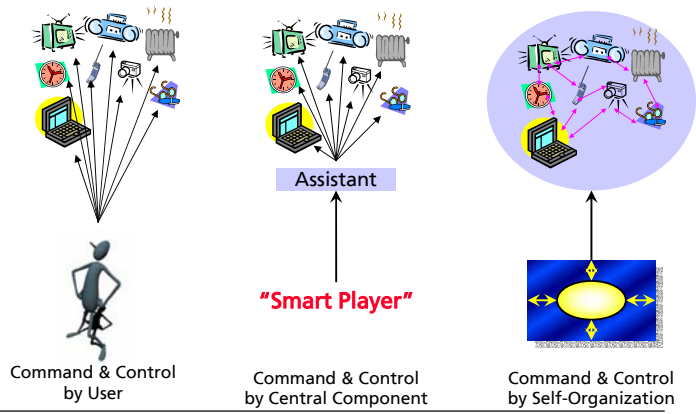
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EMBASSI: "Brighter"
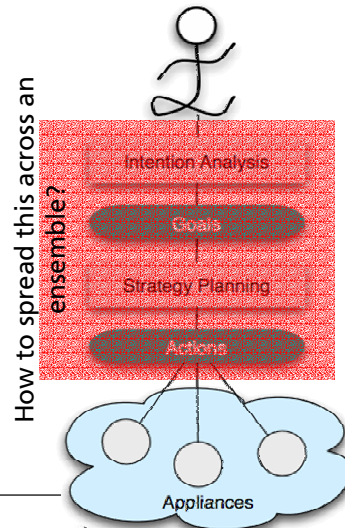
"Goal-based interaction"

Transition from a function-oriented interaction with devices to a goal-oriented interaction with ensembles

specify goal states (in terms of the smart player's perception of the state of his personal environment) rather than select functions of devices
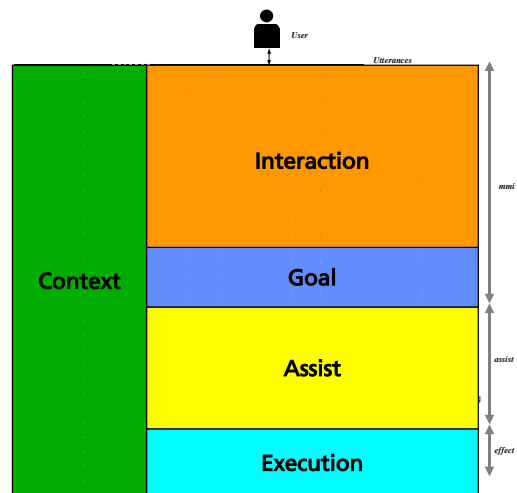
> ➢ move from device- to user-oriented vocabulary

have a strategist fill in the operations of the various devices that are required to reach the goal state

> ➢ move from an accidental collection of independent devices to a system that acts as a coherent ensemble

How to spread this across an ensemble?

Intention Analysis

Goals

Strategy Planning

Actions

Appliances

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Generic Goal Oriented Component Architecture

User

Utterances

Context

Interaction

Goal

Assist

Execution

mmi

assist

effect

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**Strategy Based
Self Organizing Topology**

Sensor   Sensor   Sensor   Sensor

Atomic Events

Strategy:
Event-Interpretation

Parser   Parser   Parser   Parser

Goals

Strategy :
Opinion Based Selection Algorithm

Assistent   Assistent   Assistent   Assistent

Strategy :
Opinion Based Selection Algorithm
Distributed Problem Solving
Multi-modal Output Coordination

Function Calls

Aktor   Aktor   Aktor   Aktor

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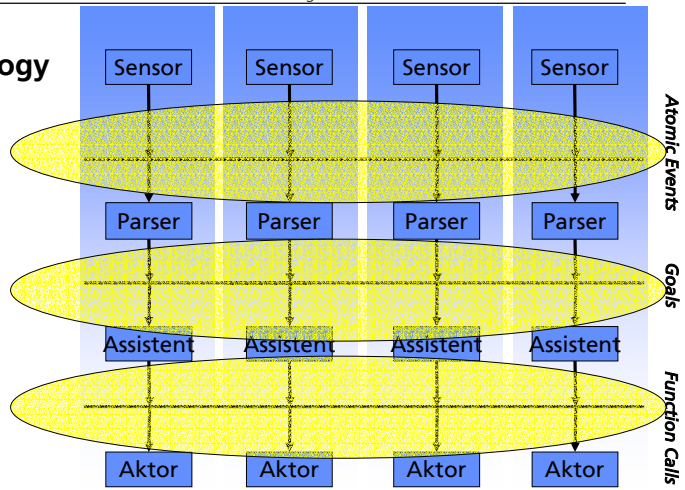
Example:
Self-Organizing
Smart Living
Room

Dramatis Personae:
The devices:
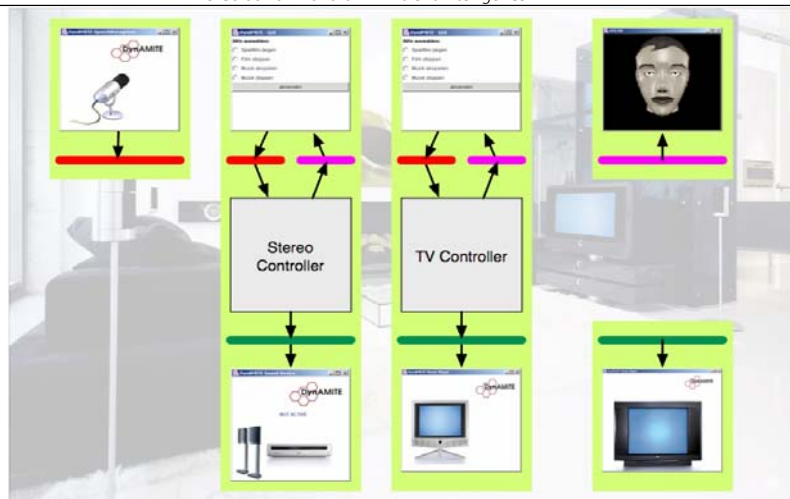
Stereo
Controller

TV Controller

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Example:
Self-Organizing
Smart Living
Room

Act I:
Devices Losing
their Boxes
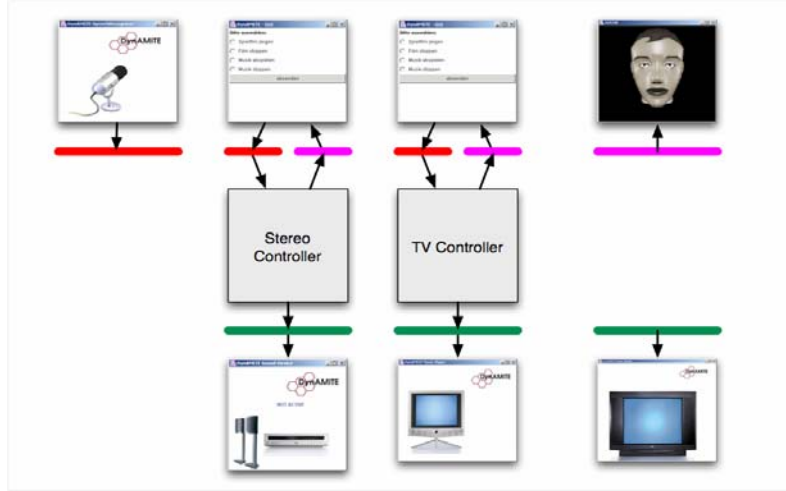
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Example:
Self-Organizing
Smart Living
Room

Act II:
Channels Lining Up
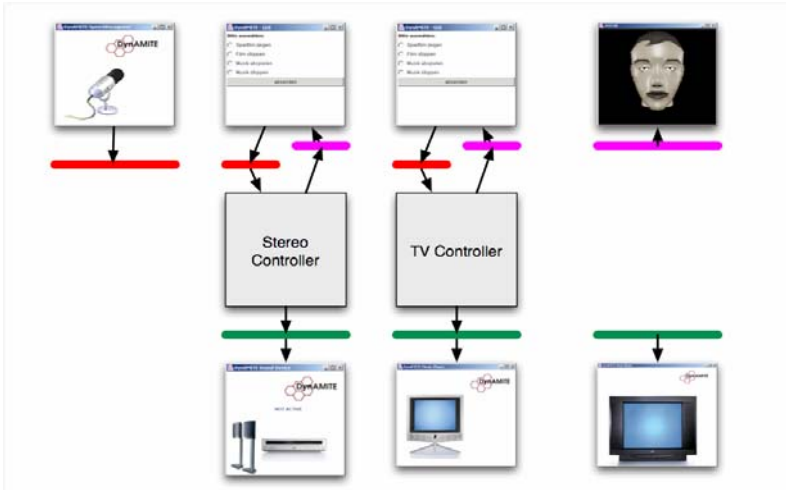
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Example:
Self-Organizing
Smart Living
Room

Act III & Finale:
Establishing the
Pipeline, Starting
Communication in
the Ensemble

Effects:
• Speech may control all devices
• Avatar may output for all devices
• TV controller may control both TV
• Stereo & TV-C cooperate in AV
output

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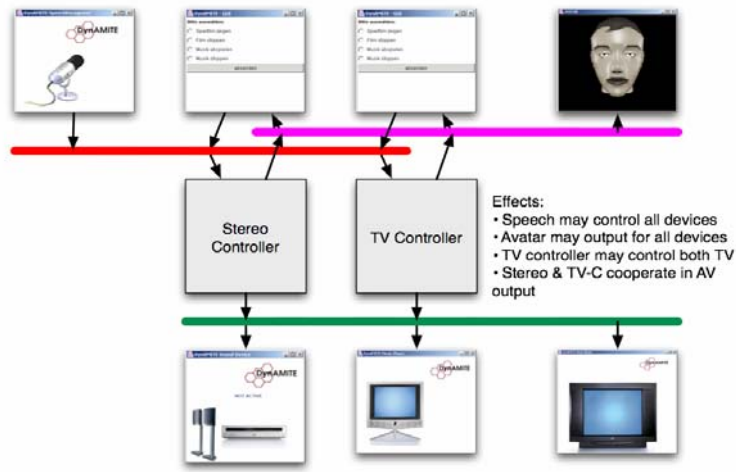
The Big Picture

➢ Vanish from thought

➢ Coherence

➢ AmI Functional System Model

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Scenarios

Be Amazed

AmI has many possible Scenarios

Example: Human Centric

| Knowledge and Interfaces | Services at home | | Services at work | | Devices: Microelectronics Microsystems, ... |

Home — Work — Enterprise

Networks: mobile, wireless, fixed, ... — Car — Smart Players — Body — Computing: Computer systems & basic Software

Services on the road — Body-focused services

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First AmI Examples:

Multimodal Interaction and Situation-Awareness (AmI at Home)

Some Smart Houses for Research

Georgia Tech
Aware Home Research Initiative
www.cc.gatech.edu/fce/ahri/

Fraunhofer Innovation Center
Intelligent House Duisburg
www.inhaus-duisburg.de

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EMBASSI (bmbf)

EMBASSI = Electronic Multimedia Operating- and Service-Assistance

Goals:

- ➢ Fill the „competence gap": make networked technical infrastructures of the everyday life usable for everyone
- ➢ Develop **personal assistance** for interacting with those infrastructures
  - ✎ Consumer Electronics, Home Environment
  - ✎ Automotive
  - ✎ Terminals, PoS/PoI
- ➢ Encourage the use of **multimedia/multi-modal UI-Technologies** by providing a Technology Toolkit
- ➢ Support all users by providing means for personal configuration and **user-adaptivity**

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EMBASSI: Paradigm Shifts

Transition from function-oriented interaction with devices to a goal-oriented interaction with systems.

- ➢ specify goal states rather than select functions of devices
- ➢ move from device- to user-oriented vocabulary
- ➢ have the assistant fill in the operations of the various devices
- ➢ move from an **accidental collection of independent devices** to a **system that acts as a coherent ensemble**

Transition from unimodal, menu-based dialogue structures to polymodal, conversational dialogue structures

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EMBASSI: Project Specifics

Interoperability of appliances; ad-hoc ensembles & self-organization

Interoperability of application areas & situations

- Private Home
- PoS / PoI-Terminals with mobile Access
- Private Vehicle

Advanced Graphics Interaction

- Support Face- and Eye-Tracking
- Support 3D Gestures
- Support High-Definition Avatars

Holistic Approach

- Psychological Background Research
- Develop Design Support Tools

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DynAMITE (bmbf)

Dynamic Adaptive Multimodal IT Ensembles

Goal:

- Develop a semantic middleware supporting context-aware self-organization of multimedia appliances
- Enable the construction of coherent ensembles
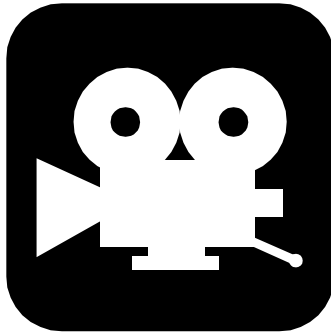- Provide a public reference implementation

Partners

- EML, IGD (Lead), Loewe

Pointers:

- www.dynamite-project.org
- First SW release available since: March 31, 2004

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Video: Personal Environment Controller

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First AmI Examples:

Location-Aware Wearable Guides (AmI Outdoor)
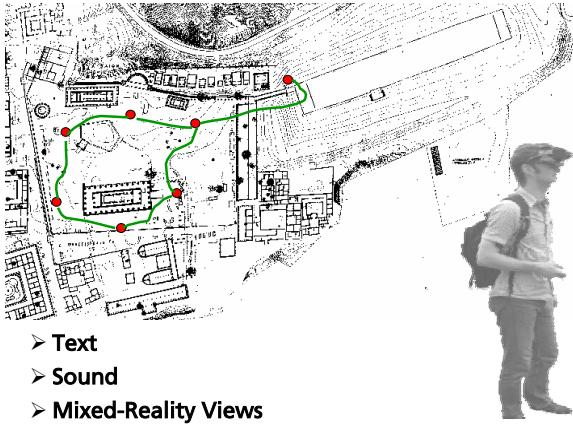

Archeoguide (EU)

Olympia 2004

➢ Mobile „Travel Guide"

➢ Enhanced view to reality

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Archeoguide (EU)

- Text
- Sound
- Mixed-Reality Views

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Archeoguide: PDA Solution

Presenting the right Information at the right time and the right place, based on:

- Location-based information selection
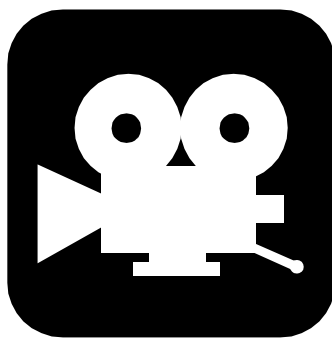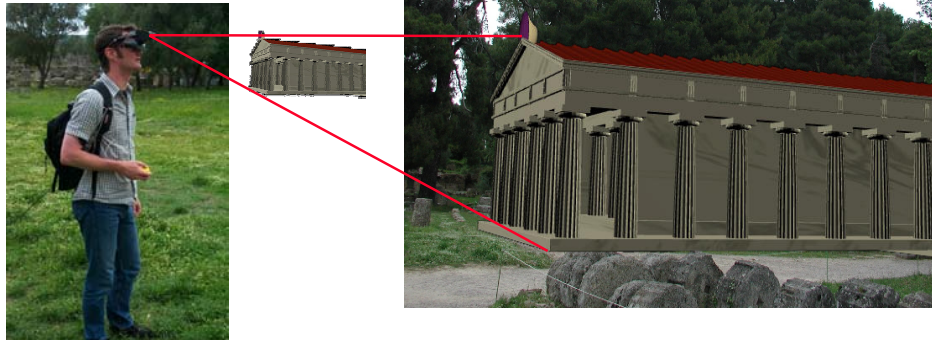- Personalization of information Profiling based on visitor profile (expert, tourist, …)

Use of image overlays for augmenting view of environment with additional information

- Leverage information reception and comprehension by visitor

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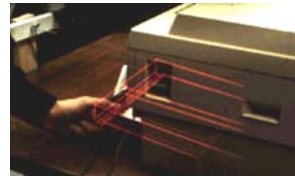**Archeoguide: Wearable System**

Video: Archeoguide

First AmI Examples:

Task-Awareness and Augmentation (AmI at Work)

Production, Maintenance, ...
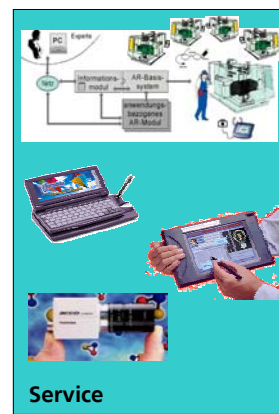
Supporting

➢ Development

➢ Production

➢ Training

➢ Service

by superposition of 3D instructions

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Maintenance ARVIKA (bmbf)

Development   **Production**   **Service**

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Video: Enhanced Objects

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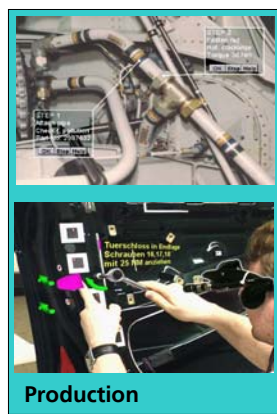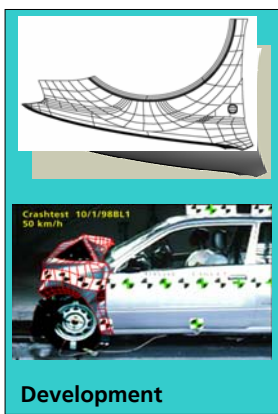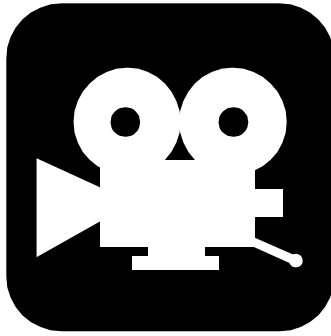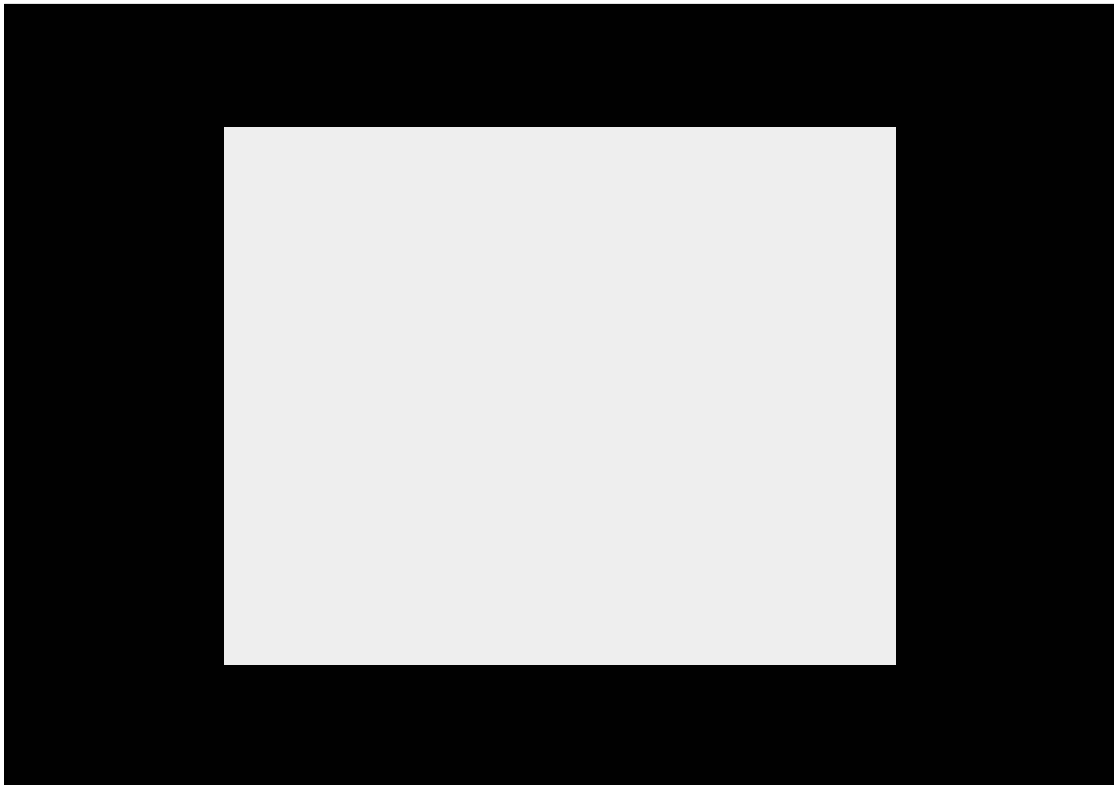
… not to forget …

EU „Disappearing Computer" Initiative, e.g.

> ➢ Ambient Agoras (Fraunhofer IPSI et al.)

> ➢ SmartIts (Lancaster University, et al.)

IBM Personal Information Appliances, BlueSpace

CMU "Aura", "Pebbles"

TeCO "Media Cup", etc.

of course Philips AmI research & HomeLab and Siemens „Pictures of the Future"

… and many more.

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AmI needs further Research and Development

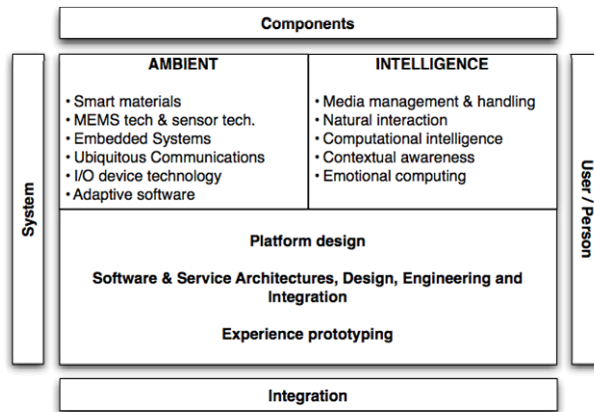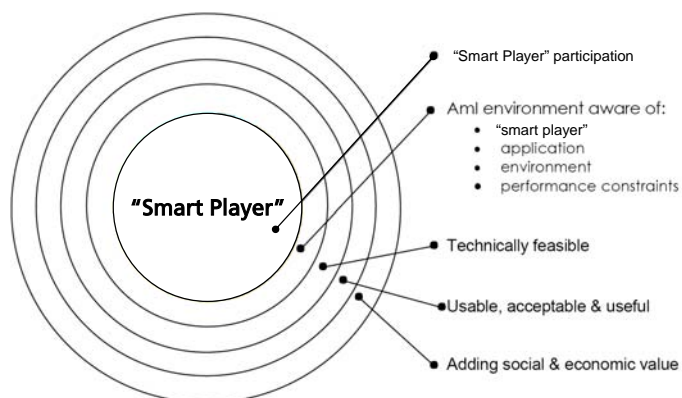| Components	
AMBIENT	**INTELLIGENCE**
• Smart materials • MEMS tech & sensor tech. • Embedded Systems • Ubiquitous Communications • I/O device technology • Adaptive software	• Media management & handling • Natural interaction • Computational intelligence • Contextual awareness • Emotional computing

Platform design

Software & Service Architectures, Design, Engineering and Integration

Experience prototyping

System

User / Person

Integration

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"Smart Player" (User) Participation is needed to make AmI happen (1)

"Smart Player"

"Smart Player" participation

AmI environment aware of:
- "smart player"
- application
- environment
- performance constraints

Technically feasible

Usable, acceptable & useful

Adding social & economic value

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"Smart Player" (User) Participation is needed to make AmI happen (2)

Make use of EARC's (http://www.cordis.lu/ist/istag-reports.htm) to

- ➢ **acquire data for redesign** in early stage of implementation
- ➢ develop **usage experience**
- ➢ guarantee "**usability**" and "**utility**"
- ➢ guarantee "**added-value**"
- ➢ **involve all players** of the supply chain
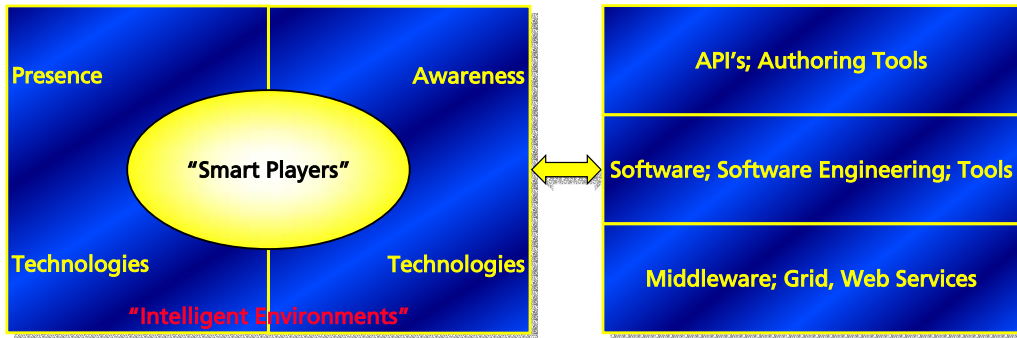- ➢ **develop business models and business cases**
- ➢ …

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Need for Support and Complementarity (1)

➢ **AmI** needs **support** and **complementarity** when we want to make it happen

➢ AmI needs advances in **Software Engineering** and **Middleware Technologies**

Presence	Awareness	API's; Authoring Tools
"Smart Players"		Software; Software Engineering; Tools
Technologies	Technologies	Middleware; Grid, Web Services
"Intelligent Environments"		

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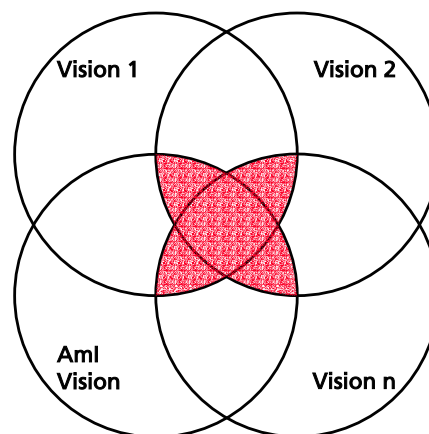Combination of Visions, **not a too early** "Extension of the of AmI Vision"

Combination of Visions (1)

➢ Guarantees the **Added-Value**

➢ Goal

    ↳ **Application and domain specific combination** (integration) of several, different visions

    ↳ Combination (integration) of visions, **not extension of one vision to embrace several**

➢ There is **a lot of R&D** to be done for this combination (integration) of several visions, especially **at the interfaces and for its optimization**

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Combination of Visions (2)

R&D for combination and integration of several visions

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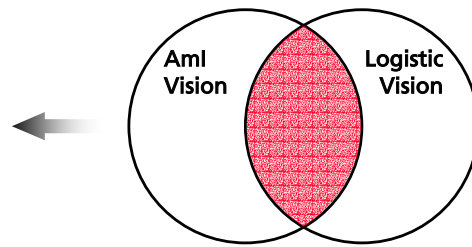Datenverarbeitung

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Combination of Visions (3)

Example 1: combination (integration) of visions

- ➢ New Paradigms for the **Support of Business Processes** based on "Intelligent Objects"

- ➢ **Use of Intelligent Objects** for

  - ↻ Intelligent Logistics

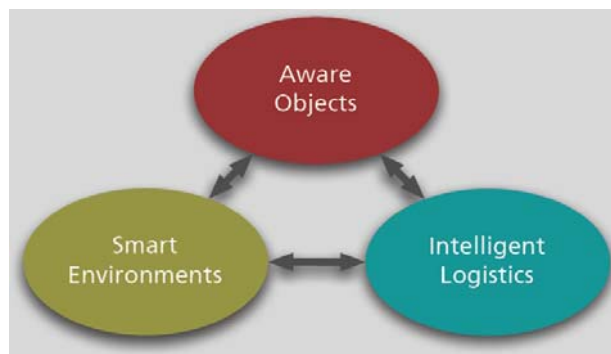 - ↻ Aware Objects

  - ↻ Smart Environments

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Combination of Visions (4)

Intelligent Logistics

- ➢ Self Organizing Logistics

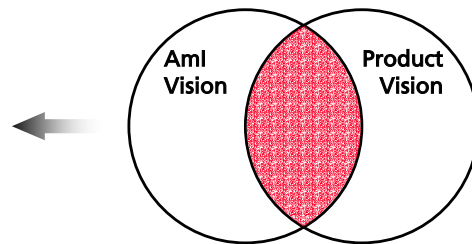- ➢ Intelligent Store Management

- ➢ …

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Combination of Visions (5)

Example 2: combination (integration) of visions

➢ New Paradigms for the **Support of Business Processes** based on "Intelligent Objects"

➢ **Use of Intelligent Objects** for

    ↳ Lifecycle Management

    ↳ Proactive Assistance

    ↳ Object Mobility

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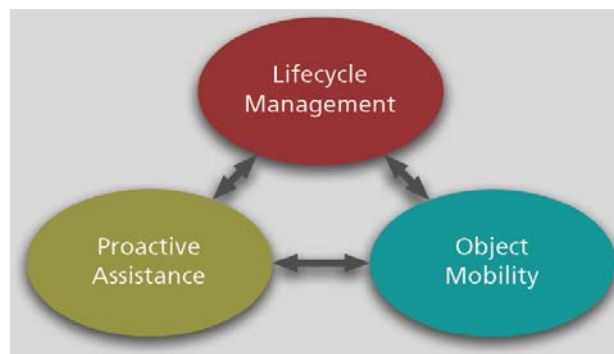Fraunhofer Institut Graphische Datenverarbeitung

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Combination of Visions (6)

Lifecycle Management (Surveillance)

➢ Track Equipment Usage

➢ Plan Maintenance According to Usage

➢ ...

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AmI needs PRESENCE and AWARENESS Technologies

TURNING GLOBAL DREAMS INTO REALITY

AmI is "one side of the coin"

To make AmI happen the "second side of the coin" is also needed in order to enable/guarantee

➢ dialogue and interaction between "intelligent environments" and "smart players" – this is the need for **PRESENCE technologies** (including VR, AR, Mixed Realities)

➢ services to be implemented need **AWARENESS technologies** (including usage, task, location, resources and performance awareness)

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PRESENCE and AWARENESS Technologies (1)

Related Research Topics

- ➢ **Infrastructures** for generating PRESENCE and for interaction

- ➢ Human PRESENCE and its **interfaces to the environment**
  (second skin; social presence; presence tuner)

- ➢ Presence **perception & measurements** (neuro-issues)

- ➢ Technologies for **capturing specific human attributes** such as emotions,
  feelings, haptic memory, etc.

- ➢ **Rendering of the 5 senses**

- ➢ API – Programming PRESENCE; **Digital Storytelling**

- ➢ **Social communication**; avatar and visual agents

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## PRESENCE and AWARENESS Technologies (2)

Possible Application Scenarios

- ➢ Presence as the **design space**;

- ➢ **Persistent hybrid communities**
  ("visiting" / participating in life of ancient and modern human communities);

- ➢ **Conflict resolution** (negotiating means understanding your interlocutor by
  occupying the standpoint of the other party – using presence technology for
  replicating such experience)

- ➢ **Behavior learning and training**

- ➢ **Presence Hall** – the ultimate presence:
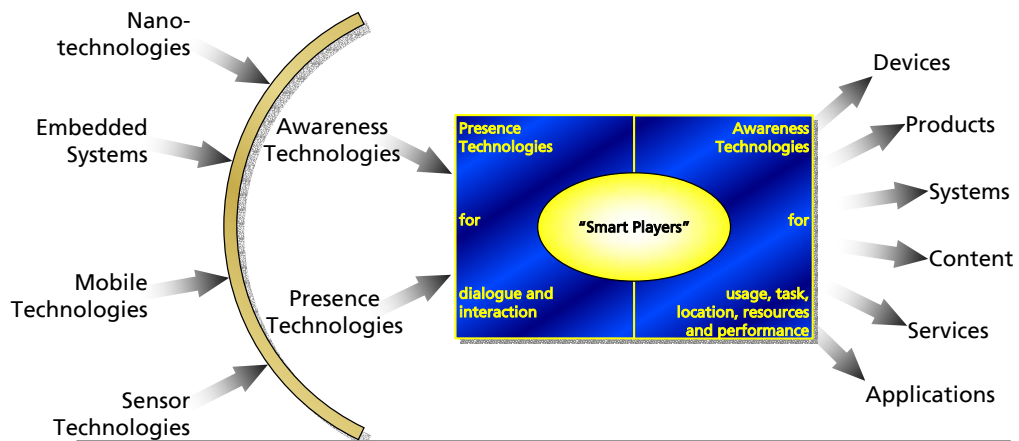 a "CAVE technology" in your home for projective immersion, etc.

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Enabling Technologies to make AmI happen

AmI

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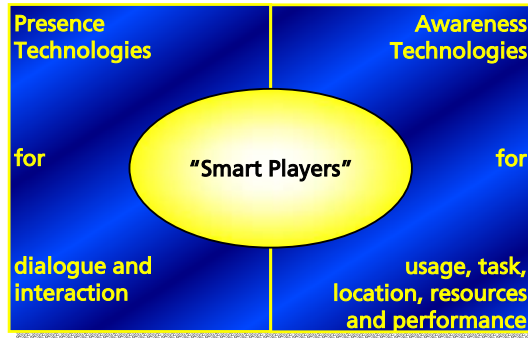
AmI source for a large range of new technologies

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AmI source for a large range of new technologies (2)

Many new Technologies

➢ Homogenous integration for a large variety of sectors

➢ Developing the next generation of primary ICT industries

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Beyond Technology. AmI Requires:

Interdisciplinarity.

➢ Integration of many different technologies

➢ Integration of non-technological disciplines (psychology, social science)

Multiculturality.

➢ Applicability across cultures and specialization towards the specific originalities of individual cultures

Interoperability.

➢ Between components developed by different companies in different nations

➢ Based on a common reference model and a shared vision

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The Colourful World of »Ambient Intelligence«

European Assets

Complex Multinational Systems:
- Across National Borders
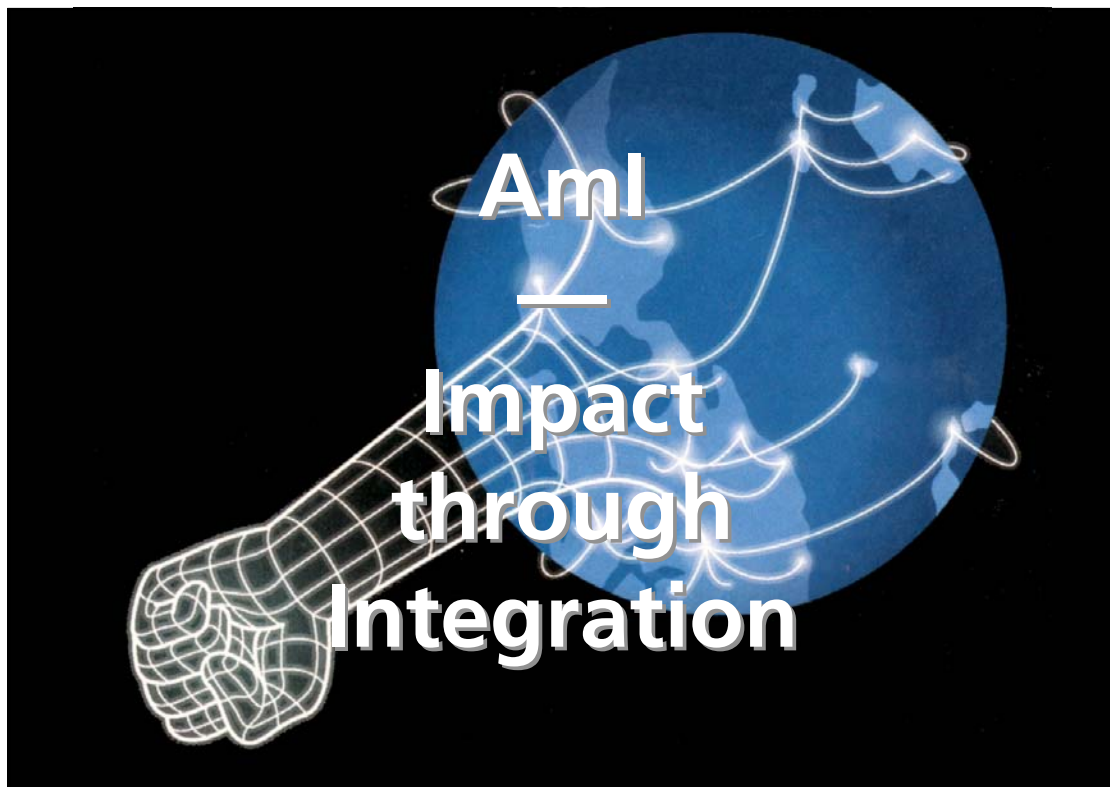- Across Language Barriers
- Across Cultures
- Across Technologies

For Instance:
- Airbus
- GSM
- Eurofighter
- Ariane

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AmI
—
Impact through Integration

Acknowledgements & Further Information

Projects

Archeoguide	www.archeoguide.com
ARVIKA	www.arvika.de
DynAMITE	www.dynamite-project.de
EMBASSI	www.embassi.de
InHaus	www.inhaus-duisburg.de

Initiatives & Groups

ISTAG	www.cordis.lu/ist/istag.htm
Disappearing Computer	www.disappearing-computer.org

Funding

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What we have to learn to do we learn by doing

Aristotle, Ethica Nicomachea II, (c. 325 B.C.)

Thank you!

Prof. Dr.-Ing. J. L. Encarnação

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